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28 JANUARY 1953
SUPERSEDING
MIL-P-2731
4 SEPTEMBER 1951

MILITARY SPECIFICATION

INSULATION PIPE COVERING, THERMAL

This specification has been approved by the Departments of the Army, the Navy, and the Air Force.

1. SCOPE

1.1 **Scope.**—This specification covers requirements for thermal insulation used for covering pipes.

1.2 **Classification.**—The thermal insulation pipe covering shall be of the following grades and classes, as specified (see 6.1):

Grade I—Temperatures up to 500° F.
- Class a—Standard density.
- Class b—Light density.

Grade II—Temperatures up to 750° F.
- Class c—Fibrous.
- Class d—Compounded.

Grade III—Temperatures 501° to 1,000° F.
- Class e—Compounded.
- Class f—Fibrous.

2. APPLICABLE SPECIFICATIONS, STANDARDS, DRAWINGS, AND PUBLICATIONS

2.1 The following specifications and standards, of the issue in effect on date of invitation for bids, form a part of this specification:

SPECIFICATIONS

FEDERAL

NN-B-591 —Boxes, Fiberboard, Wood-Cleated (for Domestic Shipment).

NN-B-601 —Boxes, Wood-Cleated-Plywood, for Domestic Shipment.

NN-B-621 —Boxes, Wood, Nailed and Lock-Corner.

QQ-S-781 —Strapping, Flat, Steel.

LLL-B-631 —Boxes, Fiber Corrugated (for Domestic Shipment).

LLL-B-636 —Boxes, Fiber, Solid (for Domestic Shipment).

MILITARY

JAN-P-105 —Packaging and Packing for Overseas Shipment — Boxes, Wood, Cleated, Plywood.

JAN-P-106 —Packaging and Packing for Overseas Shipment—Boxes, Wood, Nailed.

JAN-P-108 —Packaging and Packing for Overseas Shipment—Boxes, Fiberboard (V-Board and W-Board), Exterior and Interior.

JAN-P-139 —Packaging and Packing for Overseas Shipment—Plywood, Container Grade.

MIL-L-10547 —Liners, Case, Waterproof.

NAVY DEPARTMENT

General Specifications for Inspection of Material.

STANDARDS

MILITARY

MIL-STD-105—Sampling Procedures

202392—53—(956)

TABLE I.—*Physical requirements.*

Characteristics	Method of test, paragraph	Grade I		Grade II		Grade III	
		Class a	Class b	Class c	Class d	Class e	Class f
Density lbs./cu. ft., maximum	4.7.4	16.00	12.00	15.00	15.00	27.00	25.00
Thermal conductivity, B.t.u./hr./sq. ft./°F./inch maximum, at a mean temperature of:							
300° F.	4.7.5	0.55	0.50	---	---	---	---
400° F.	4.7.5	---	---	0.46	0.60	---	---
550° F.	4.7.5	---	---	---	---	0.80	0.65
Hardness, penetration, mm. maximum	4.7.6	1.00	1.15	0.40	1.00	0.80	0.40
Resistance to abrasion, percent: Loss in weight, maximum:							
After first 10 minutes	4.7.7	40	40	---	40	55	---
After last 10 minutes	4.7.7	70	70	---	70	80	---
Modulus of rupture, lbs./sq. in., minimum	4.7.8	[1]	[1]	[1]	[1]	[1]	[1]
Changes under soaking heat for 6 hours at __° F.		500	500	750	750	1,000	1,000
Hardness, mm. penetration, maximum	4.7.6	1.15	1.40	0.70	1.15	1.10	0.70
Loss in weight, percent, maximum	4.7.9	18.00	18.00	6.00	12.00	16.00	6.00
Linear shrinkage, percent, maximum	4.7.9	2.00	2.00	1.00	2.00	2.00	1.00
Moisture absorption, percent by volume, maximum	4.7.10	1.00	1.00	2.00	3.00	3.00	2.00

[1] Three times density (lbs. per cu. ft.) of the sample tested.

and Tables for Inspection by Attributes.

MIL-STD-129—Marking of Shipments.

(Copies of specifications, standards, and drawings required by contractors in connection with specific procurement functions should be obtained from the procuring agency or as directed by the contracting officer.)

3. REQUIREMENTS

3.1 Qualification.—The thermal-insulation pipe covering furnished under this specification shall be a product which has been tested and has passed the qualification tests specified in section 4 (see 6.2).

3.2 Material.—The pipe covering shall be composed of heat-resisting compounds suitable for the temperature conditions and the purpose intended.

3.3 Composition.—The pipe covering shall conform in all respects to the composition obtained on the sample submitted for qualification (see 4.7.2).

3.4 Stability.—The pipe covering shall pass the shock and vibration test specified in 4.7.3.

3.5 Length.—Sections shall be 3 feet long, split in half lengthwise. Curved segments shall be 3 feet long and of suitable width to properly fit the respective pipe sizes.

3.6 Tolerance.—A tolerance of minus zero and plus ¼ inch in length will be permitted.

3.7 The pipe covering shall conform to the physical requirements shown in table I.

3.8 Thickness.

3.8.1 *Grade I—classes a and b, and grade II—class d.*—Unless otherwise specified in the contract or order, the minimum thickness of grade I, classes a and b, and grade II, class d coverings for the various sizes of pipe shall be as shown in table II.

3.8.1.1 *Single standard.*—Single standard pipe coverings for sizes ½ inch and up to and including 10 inches shall be furnished in sections. Pipe covering for sizes larger than 10 inches shall be furnished in segments or sections.

TABLE II.—*Thickness.*

Nominal pipe sizes *Inches*	Single standard (inches)	Double standard (inches)
Up to 1½, inclusive	⅞	1¾
2 to 3½, inclusive	1	2
7 to 11, inclusive	1¼	2½
12 and over	1½	3

Note.—In addition to thickness specified, standard thickness of 1½ inches in single layer or a standard thickness of 3 inches in double layer may be specified for nominal sizes up to 12 inches.

3.8.1.2 *Double standard.*—Double standard pipe covering may be furnished in two layers to form total required thickness. Sections may be furnished for all sizes. Where two layers are furnished, the inner layer for sizes larger than 10 inches and the outer layer for sizes larger than 8 inches may be furnished in segments.

3.8.2 *Grade II—class c.*—Unless otherwise specified in the contract or order, the minimum thickness of grade II, class c covering for the various sizes of pipe shall be as shown in table III.

TABLE III.—*Thickness.*

Nominal pipe sizes (inches)	Single standard (inches)	Double standard (inches)
1½ and smaller	¾	1½
2 to 6, inclusive	1	2
7 to 11, inclusive	1 5/32	2 5/16
12 and over	1⅜	2¾

Note.—In addition to thickness specified, standard thickness of 1½ inches in single layer or a standard thickness of 3 inches in double layer may be specified for nominal sizes up to 12 inches.

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TABLE IV.—*Thickness.*

Nominal pipe sizes (inches)	Single layer (inches)	Double layer		
		Inner layer (inches)	Outer layer (inches)	Total (inches)
Up to 1½, inclusive	1 5/16	---	---	---
2, 2½, 3½, 4½	---	1¼	1 3/16	3 1/16
3, 4, 5, 6, 7	---	1½	2	3½
8 and over	---	2	2	4

3.8.2.1 *Single and double standard.*—Single and double standard pipe covering shall be furnished in a single layer and in sections for all pipe sizes.

3.8.3 *Grade III—class e.*—Unless otherwise specified in the contract or order, the minimum thickness of grade III, class e covering for the various sizes of pipe shall be as shown in table IV.

3.8.3.1 *Single layer.*—Single layer for pipe sizes 1½ inches and smaller shall be furnished in sections.

3.8.3.2 *Double layer.*—The inner layer for pipe sizes 2 to 8 inches, inclusive, and the outer layer for pipe sizes 2 to 7 inches, inclusive, shall be furnished in sections. The inner layer for pipe sizes larger than 8 inches and the outer layer for pipe sizes larger than 7 inches shall be furnished in either segments or sections. Double layer covering may be furnished in a single layer. In this case, the two parts may be either integral or cemented together to form a symmetrical properly fitting unit. Segments shall not be cemented.

3.8.4 *Grade III—class f.*—Unless otherwise specified in the contract or order, the thickness of grade III, class f pipe covering for the various sizes of pipe shall be as shown in table V.

3.8.4.1 *Single layer.*—Single layer for pipe sizes 1½ inches and smaller shall be furnished in sections.

3.8.4.2 *Double layer.*—The inner and the outer layer shall be furnished in sections. Double layer covering may be furnished in a single layer. In this case the two parts may be either integral or cemented together to

TABLE V.—*Thickness.*

Nominal pipe sizes	Single layer 751° to 1,000° F.	Double layer					
		Temperature 751° to 850° F.			Temperature 851° to 1,000° F.		
		Inner layer	Outer layer	Total	Inner layer	Outer layer	Total
Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
Up to 1½, inclusive	2	---	---	---	---	---	---
2 to 3½, inclusive	--	1¼	1¾	3	1¾	1½	3¼
4 to 6, inclusive	--	1¼	1¾	3	2	1½	3½
7 to 11, inclusive	--	1½	2	3½	2	2	4
12 and larger	--	1½	2½	4	2	2	4

form a symmetrical, properly fitting unit. Segments shall not be cemented.

3.9 **Outer layer, grade III.**—The outer layer of grade III, double layer pipe shall conform to grade I, class a or b, or grade II, class c or d of this specification.

3.10 Sectional pipe covering, grade I, classes a and b, grade II, class d, and grade III, class e, up to and including 1½- inch pipe size, shall be furnished with a cloth or paper jacket covering the entire length.

3.11 **Workmanship.**—The workmanship shall be first class in every respect.

4. SAMPLING, INSPECTION AND TEST PROCEDURES

4.1 Inspection procedures.—For naval purchases, the general inspection procedures shall be in accordance with General Specifications for Inspection of Material.

4.2 Qualification tests at a Government laboratory.—Qualification tests shall be conducted at a Government laboratory designated by the Bureau of Ships. These tests shall consist of the tests specified in 4.7.

4.3 Sampling for lot acceptance.

4.3.1 *Inspection lot.*—All half sections or segments of pipe covering of the same grade and class presented at one time shall be considered a lot for purposes of acceptance inspection and tests.

4.3.2 *Sampling for inspection.*—A random sample of half sections or segments shall be selected in accordance with table VI from each inspection lot of material offered for Government inspection of visual, dimensional, and density characteristics, with lot acceptance based on sampling inspection requirements in accordance with Standard MIL–STD–105.

4.3.3 *Sampling for lot acceptance tests.*—A random sample of half sections or segments shall be selected from each inspection lot in accordance with table VII, and subjected to the hardness and modulus of rupture tests specified in 4.7.6 and 4.7.8.

TABLE VI.—*Sampling for visual, dimensional, and density inspection AQL (approx.) = 2.5 percent defective.*

Number of half sections or segments in inspection lot	Number of half sections or segments in sample	Acceptance number (defectives)	Rejection number (defectives)
40 and under	5	0	1
41 to 110	7	0	1
111 to 500	10	0	1
501 to 1,300	15	1	2
1,301 to 3,200	25	1	2
3,201 and over	35	2	3

Note.—The Government inspector shall institute tightened inspection in accordance with Standard MIL–STD–105. Reduced inspection may be instituted by the Government inspector in accordance with Standard MIL–STD–105.

4.3.4 *Sampling for production check tests.* The Government inspector shall select two half sections or segments from every 10 lots of material offered for delivery. The samples shall be chosen so that over a period of time, a representative selection of grades, classes, and sizes will be sampled. Samples so selected shall be forwarded to the Engineering Experiment Station, Annapolis, Md., for the tests specified in 4.6. Each sample shall be properly marked with the

TABLE VII.—*Sampling for lot acceptance tests.*

Number of half sections or segments in inspection lot	Number of half sections or segments in sample	Acceptance number	Rejection number
		(Number of items nonconforming on any lot acceptance test)	
40 or under	2	0	1
41 to 110	3	0	1
111 to 500	5	0	1
501 to 1,300	7	0	1
1,301 and over	10	0	1

contractor's name, product name, grade, and contract or order number.

4.4 **Inspection.**

4.4.1 *Visual and dimensional and density inspection.*—Each of the sample half sections or segments selected in accordance with table VI shall be visually and dimensionally inspected and the density determined (see 4.7.4) by the Government inspector to verify compliance with this specification. Any half section or segment in the sample containing one or more visual, dimensional, or density defects shall be rejected, and if the number of defective half sections or segments in any sample exceeds the acceptance number for that sample, the lot represented by the sample shall be rejected.

4.5 **Lot acceptance tests.**

4.5.1 *Testing of sample half sections or segments for lot acceptance.*—Two specimens from each of the sample half sections or segments selected in accordance with table VII shall be subjected to the hardness and modulus of rupture tests in accordance with 4.7.6 and 4.7.8 to verify compliance with this specification. Any sample specimen which does not meet the requirements for any of these characteristics shall cause rejection of the lot represented by the sample.

4.6 **Production check tests.**

4.6.1 *Test procedure.* — The samples selected as specified in 4.3.4 shall be subjected to those of the tests specified in 4.7 which, in the opinion of the Government inspector and the Engineering Experiment Station, are necessary to establish equivalence with the previously approved quality.

4.6.2 *Action in case of failure.*—Lot acceptance and rejection shall normally be on the basis of the sampling, inspection, and tests specified in 4.3.2, 4.3.3, 4.4, and 4.5 only, and acceptance will not be withheld pending receipt of the test report on the production check test samples. However, upon receipt of an unsatisfactory test report on any sample chosen for production check test, the Government inspector shall thenceforth select two sample half sections or segments from each lot of material of the same grade and class as that of the sample which failed the production check test. These samples shall be forwarded to the Engineering Experiment Station as specified in 4.3.4, for the test or tests wherein failure was observed. Lots so sampled shall be accepted only upon receipt of a satisfactory test report from the Engineering Experiment Station. This additional testing shall be discontinued and lot acceptance returned to the normal basis of 4.3.3, 4.4, and 4.5, when four successive lots have been accepted.

4.7 **Test procedures.**

4.7.1 *Conditioning samples.*—Test specimens for inspection and for qualification shall be dried to constant weight by heating to 220° to 230° F. (105° to 110° C.) before testing.

4.7.2 *Composition.*—The composition shall be determined by chemical analysis, using accepted laboratory methods.

4.7.3 *Stability.*—The ability of the pipe-covering materials to withstand shock and vibration shall be determined from sections of the materials applied and secured between two circular 9½-inch diameter metal disks located 36 inches apart on a section of 3-inch pipe. The pipe, with the material applied, shall be connected in a horizontal position in a vibration machine. In this position the materials shall be subjected to 700 vibrations per minute through an arc of 15 minutes with a radius of 30 inches, for a period of at least 96 hours.

4.7.4 *Density.*—Half sections shall be carefully measured and weighed, from which the density shall be determined.

4.7.5 *Conductivity.*—For this test, the sample shall be a 3-foot sectional cover for a 3-inch pipe. Conductivity shall be determined on a pipe-test apparatus at several temperatures up to 500°, 750° and 900° F., respectively.

4.7.6 *Hardness.*—Hardness shall be determined on the plastometer, a commercial instrument consisting mainly of two parallel metal disks supported on uprights, to which are fastened a thin rod with a ⅛-inch diameter ball point, a measuring gage graduated in 1/100 mm. divisions, and a kilogram weight. A specimen of the material to be tested shall be placed under the instrument, and the ⅛-inch ball point shall be brought down on the surface of the specimen corresponding to the outside as received, until the index hand of the measuring gage makes two complete revolutions. The kilogram weight shall then be slowly released from its supporting disk and allowed to rest on a shoulder of the ball point holder, causing the ball point to sink into the specimen. The depth that the ball point is depressed into the specimen shall then be read on the graduated measured gage dial to 1/100 of a millimeter.

4.7.7 *Abrasion test.* — The structural strength shall be determined by the abrasion test. In this test, twelve 1-inch cube specimens of the material and twenty-four ¾-inch oak cubes (specific gravity of the wood 0.65) shall be placed in an oak box having inside dimensions of 7½ by 7¾ by 7¾ inches. The opening of the box shall then be closed and the box rotated about its own axis at a speed of 60 revolutions per minute for two 10-minute periods. At the end of each 10-minute period, the cubes of the material under test shall be removed from the box and the percentage of loss in weight, due to pulverization and breakage, shall be determined.

4.7.8 *Modulus of rupture.*—The test for determining the modulus of rupture of the materials shall consist of supporting specimens of the materials on 10-inch centers and suspending a load from a saddle centrally located on the specimens with an increase of load until the specimens are broken. The specimens shall be 12 inches in length and in quadrants from the inner and outer layers of the pipe covering. The saddles and centers shall be constructed to conform to the curvature of the specimens. Ten specimens of each layer shall be used for the test. The modulus of rupture shall be the average of the results on all specimens. The following equation shall be used in computing the modulus of rupture:

$$S = \frac{0.25WD\left[R - \frac{0.6\,(R^3 - r^3)}{(R^2 - r^2)}\right]}{0.3214\,(R^4 - r^4) - \frac{0.2829\,(R^3 - r^3)^2}{(R^2 - r^2)}}$$

where:

S = Modulus of rupture (pounds per square inch).
W = Breaking load (pounds).
D = Distance between centers of supports (inches).
R = Radius of outer periphery of pipe-covering specimens (inches).
r = Radius of inner periphery of pipe-covering specimens (inches).

4.7.9 *Heating loss and shrinkage.*—Carefully sized specimens shall be placed in an electrically heated oven. Specimens shall be heated at 500°, 750°, and 1,000° F., respectively, for grades I, II, and III for 6 hours. After removal from the oven, the specimens shall be examined to determine loss in weight, linear shrinkage, and change in hardness.

4.7.10 *Moisture absorption.* — Duplicate specimens, each having a total area of 72 square inches, shall be subjected to an atmosphere of 90 percent, relative humidity at 120° F., dry-bulb temperature, for 6 hours. The increase in weight shall be noted and recorded as percentage increase in weight and volume.

4.8 **Rejected lots.**—Rejected lots may be offered again for Government inspection provided the contractor has repaired or removed all nonconforming half section or segments. The Government inspector shall again select and examine samples from each resubmitted lots to verify compliance with this specification.

5. PREPARATION FOR DELIVERY

5.1 Packing.

5.1.1 *For domestic shipment and storage.*—Unless otherwise specified in the contract or order, the pipe covering shall be packed in snug-fitting wood cleated fiberboard, cleated plywood, nailed wood, corrugated, or solid fiberboard boxes conforming to Specification NN–B–591, NN–B–601, NN–B–621, LLL–B–631 or LLL–B–636, respectively. Fiberboard boxes shall conform to the special requirements of the applicable box specification. Closure of the boxes shall conform to the applicable container specification. Fiberboard when used shall have a Mullen test of 275 pounds. The gross weight of wood boxes shall not exceed 200 pounds unless the weight of the individual item exceeds this amount. Fiberboard boxes shall not exceed the weight limitations of the applicable box specification.

5.1.2 *For oversea shipment.*—When specified in the contract or order, the pipe covering shall be packed in snug-fitting wood cleated plywood, nailed wood or fiberboard boxes conforming to Specification JAN–P–105, style 2, 2½ or 3 of Specification JAN–P–106, or symbol V3c or V3s of Specification JAN–P–108, respectively. Plywood shall conform to type A or B, condition I of Specification JAN–P–139. Boxes shall be fitted with a sealed waterproof case liner conforming to type I, grade B, class 2 of Specification MIL–L–10547 and appendix thereto. Shipping containers shall be closed and strapped in accordance with the appendix of the applicable container specification. Flat steel strapping shall conform to class A or B of Specification QQ–S–781. The gross weight of wood boxes shall not exceed 150 pounds unless the weight of the individual item exceeds this amount, of fiberboard boxes, 70 pounds.

5.2 Marking.—In addition to any special marking required by the contract or order, interior packages and shipping containers shall be marked in accordance with Standard MIL–STD–129.

6. NOTES

6.1 Ordering data.—Procurement documents should specify the following:

(a) Title, number, and date of this specification.
(b) Grade and class required (see 1.2).
(c) Whether domestic or oversea packing is required (see sec. 5).

6.2 In the procurement of products requiring qualification, the right is reserved to reject bids on products that have not been subjected to the required tests and found satisfactory for inclusion on the Military Qualified Products List. The attention of suppliers is called to this requirement, and manufacturers are urged to communicate with the Bureau of Ships, Navy Department, Washington 25, D. C., and arrange to have the products that they propose to offer to the Army, the Navy, or the Air Force, tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. Information pertaining to qualification of products covered by this specification may be obtained from the Chief of the Bureau of Ships, Navy Department, Washington 25, D. C.

6.3 Superseding documents.—This specification supersedes MIL–P–2781. The latter superseded Navy Specification 32P8d.

Custodians:
Army—Corps of Engineers
Navy—Bureau of Ships
Air Force

Other interest:
Army—OT
Navy—SY.

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